# A SUMMARY OF FACTS REGARDING MALARIA

SUITABLE FOR PUBLIC INSTRUCTION

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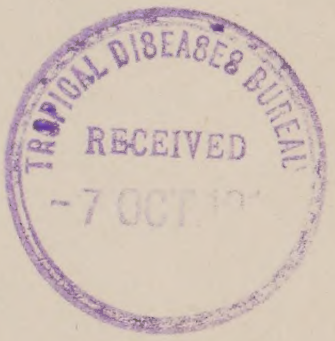


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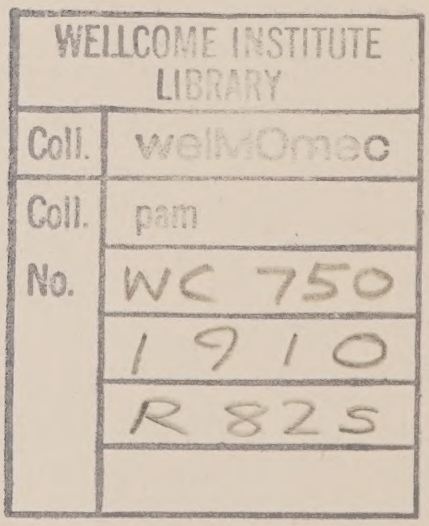
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# A SUMMARY OF FACTS REGARDING MALARIA

*Suitable for Public Instruction*[1]

1. **The Parasites and the Fever.** — Malaria, or Malarial Fever, is also known by the names Paludism, Marsh Fever, Jungle Fever, Ague and Periodic Fever. It is often called by local names such as Country Fever, West African Fever, Burma Fever; and varieties of it are called Intermittent Fever Remittent Fever, Pernicious Fever and Blackwater Fever.

Malarial fever occurs more or less in all warm climates, especially in the summer, after rains, and near marshy ground; and causes a quarter or more of the total sickness in the tropics.

It is caused by enormous numbers of the minute parasites of the blood called *Plasmodia.*

These parasites are introduced into the blood through the proboscis of certain species of the mosquitos called Anophelines.

On being introduced, each parasite enters one of the red corpuscles of the blood, in which it lives and grows.

On reaching maturity each parasite produces a number of spores which escape from the containing corpuscle, and enter fresh corpuscles; and this method of propagation may be continued indefinitely for years.

Thus, though only a few hundreds or thousands of the parasites may have been originally introduced through the mosquito's proboscis, their number rapidly increases until as many as some millions of millions of them may exist in the blood.

At first, while the number of parasites is still small, the

[1] From Professor Ross's book on the "Prevention of Malaria" (John Murray, London).

infected person may remain apparently well. When, however, the number is large enough, he begins to suffer from fever.

The parasites tend to produce their spores all at the same time; and it is at the moment when these spores escape that the patient's fever begins.

The fever is probably caused by a little poison which escapes from each parasite with the spores.

After from six to forty hours or more this poison is eliminated from the patient's system; and his fever then tends to leave him.

In the meantime, however, another generation of parasites may be approaching maturity, and may cause another attack of fever like the first; and so on, indefinitely for weeks or months. In this manner the attacks of fever follow each other at regular intervals.

But it often happens that before one attack has entirely ceased another one commences; so that the attacks overlap each other, and the fever is continued.

After a time, even without treatment, the number of parasites may decrease, until not enough of them are left to produce fever; when the patient improves temporarily.

It generally happens, however, sooner or later, that the number of parasites increases again; when the patient again suffers from another series of attacks.

Such relapses are frequently encouraged by fatigue, heat, chill, wetting, dissipation and attacks of other illness.

They may occur at intervals for a long time after the patient was first infected, and after he has moved to localities where there is no malaria.

It is probable that as long as one parasite remains alive in the patient's blood he may remain subject to such relapses.

Besides fever, the parasites often produce anaemia and enlargement of the spleen, especially in patients who have suffered from many relapses.

Death is sometimes caused by sudden and grave symptoms.

Chief among these are the symptoms known as Blackwater Fever, or Haemoglobinuria, which generally occurs in old and neglected infections.

Death is also often caused during the course of a malarial infection by other diseases, such as pneumonia or dysentery, acting upon a constitution already enfeebled by the parasites.

If the patient survives, the parasites tend to die out of themselves, without treatment, after a long period of illness—leaving him more or less "immune."

The parasites are at least of three kinds, which can easily be distinguished in blood placed under the microscope. These are (1) the parasite which produces its spores every three days and causes *quartan fever;* (2) the parasite which produces its spores every other day, and causes *tertian fever;* (3) parasites which cause the so-called *malignant fever*, in which dangerous complications most frequently occur.

If a little blood containing any one of these species of parasites is taken from a patient, and is then injected into a vein of a healthy person, the latter will almost certainly soon become infected with the same species of parasite.

Closely similar parasites are found in monkeys, bats, squirrels and birds.

As proved by centuries of experience, cinchona bark, from which quinine is made, possesses the power of destroying the parasites and curing the infection. But it will not generally destroy all the parasites in the body unless it is given in sufficient doses and continued for several months; and as long as a single parasite remains alive in the blood, infection is continued and the patient may be subject to relapses. At least five grains (1/3 gramme) of sulphate of quinine should be taken by an adult patient every day without fail for four months; but he should consult a medical man regarding details of the treatment.

**2. The Mode of Infection.**—Besides those forms of the

malaria parasite which produce spores in the human body, there are other forms, male and female.

When certain species of the mosquitos called Anophelines happen to feed on a patient whose blood contains the parasites of malaria, these are drawn with the blood into the insect's stomach.

If the sexual forms of the parasites are present these undergo certain changes in the mosquito's stomach; the females pass through its wall; and finally fix themselves to its outer surface—that is, between the stomach and the skin of the insect.

In this position they grow largely in size, and after a week, in favourable circumstances, produce a number of spores.

The spores find their way into the insect's salivary glands. This gland secretes the irritating fluid which the insect injects through its proboscis under the human skin when it commences to feed; and the spores can easily be found in the fluid by the microscope.

Thus when a proper species of Anopheline, which has more than a week previously fed upon a patient containing the sexual forms of the parasites of malaria, next bites another person, it injects the spores, together with its saliva, under his skin—that is, generally into his blood.

These spores now cause, or may cause, infection or re-infection in this second person, as described at the beginning of this summary.

Numerous birds and men have been infected experimentally in this manner.

Thus the parasites of malaria pass alternately from men to certain mosquitos, and back from these mosquitos to men.

A very large number of parasites are known which pass in this manner from one animal to a second animal which preys on the first; and back again from the second animal to the first.

It is not known with certainty when and how this process first commenced; but probably all such parasites were originally free living animals, which by the gradual evolution of ages acquired the power of living in other animals.

Thus also, it is evident that malarial fever is an infectious disease which is communicated from the sick to the healthy by the agency of certain mosquitos.

From the time of the ancients it has been known that malarial fever tends to be most prevalent in the vicinity of marshes.

The parasites of malaria have never been found in the water or air of marshes; nor in decaying vegetation; nor in the soil. Attempts to produce infection by these have always failed. But the Anophelines which carry the parasites breed in marshes and in marshy pools and streams.

Rising from these marshes, they enter the adjacent houses and feed on the inmates, mostly at night; biting first one person and then others; and living for weeks or months.

If an infected person happens to be present in any of these houses, the infection is likely to be carried by the Anophelines from him to the other inmates, and to neighbouring houses.

Thus the whole neighbourhood tends to become infected, and the locality is called "malarious."

In such localities, it is easy to find the parasites of malaria in the Anophelines of the proper species; even in as many as 25% or more of them.

Such Anophelines when taken from a malarious locality to a healthy one (*e.g.*, from the Campagna near Rome to London) will still infect healthy persons whom they have been caused to bite.

So also, in malarious localities, the Anophelines bite the healthy new-born children, and infect many of them.

Such children, if not thoroughly treated, may remain infected for years; may become anaemic and possess enlarged

spleens; and may spread the infection to others. Later, however, at the age of twelve years or more, the survivors tend to become "immune."

In many malarious localities almost every child has been found to contain the parasites of malaria, or to possess an enlarged spleen.

In such a locality therefore, the infection is constantly passed on from the older children, or from adults, to the new-born infants; so that the locality may remain malarious for years, or for centuries.

Similarly, a new-comer arriving in such a locality is very likely to become infected, especially if he sleeps in an infected house even for one night.

A locality is said to be malarious only when healthy persons become infected in it; not when persons who have become infected elsewhere happen to reside in it.

A locality is malarious only when it contains persons already infected with the parasites, and also sufficient numbers of the proper species or varieties of Anophelines to carry the infection to healthy persons.

The chances of infection tend to be great in localities where there are already numerous infected persons, not treated with quinine; or where there are numerous Anophelines of the proper species, not prevented from biting.

Conversely, the chances of infection tend to be less where infected persons are excluded, or properly treated with quinine; or where the Anophelines are few in number, or are prevented from biting.

**3. Facts about Mosquitos.** — Gnats, which in the tropics are commonly called mosquitos, belong to the zoological family of Insects known as the Culicidae (from the Latin *culex*, a gnat). They are distinguished from other insects by a number of characters; and always possess only one wing on each side, and a long proboscis.

Like that of other insects, their life is divided into four stages, the *egg;* the *larva* (or caterpillar); the *pupa* (or chrysalis); and the *imago* (or adult, winged insect).

The *egg* is laid on water or near it, and in warm, moist weather hatches out in a day or two.

The *larva* is entirely aquatic, and always lives in water. It swims and dives by means of paddles and hairs, and feeds on various aquatic organisms. It cannot, however, breathe under water, but must always rise to the surface in order to obtain air. After a week or more it becomes a pupa.

The *pupa* still remains in the water, generally floating on the surface. After two days or more its skin cracks, and the imago emerges.

The *imago* remains standing for a little while on the empty floating skin of the pupa, and then flies away.

Both males and females are able to suck fluids through the proboscis. As a rule the male feeds only on the juices of plants; but the female sucks the blood of men, beasts, birds and reptiles. The female often returns to water every few days in order to lay her eggs, of which she may deposit several hundreds at a time; and then seeks another meal.

Female gnats have been kept alive in captivity for months.

In unsuitable weather both males and females may take refuge in damp places such as cellars, wells, out-houses and woods, where they may remain for months until better conditions prevail.

As a rule gnats, like other animals, tend to remain in the locality where they were born; but a few may occasionally stray to the distance of half a mile or more from their breeding places. If, however, plenty of places where they can obtain food exist near at hand, there is no reason why they should travel further for it. They must also remain near water to drink and to lay their eggs in.

Gnats are generally favoured by warm weather, by plenty of water suitable for their larvae, and by abundance of food.

They tend to be diminished by various kinds of bats, birds, fish, insects and spiders which devour them or their larvae.

During its life, a single gnat may succeed in biting many persons or animals, and in propagating diseases amongst them.

The family of Culicidae or Gnats is divided into many sub-families and genera, and contains some five or six hundred known species.

Although all these species have many habits and structural characters in common, yet they all differ in small details. These have been described at length in a number of special books written on the subject.

In the tropics, as a broad general rule, the gnats which most concern human beings belong to the groups called *Culex*, *Stegomyia* and *Anophelina*.

*Culex pipiens* is a very common gnat in Europe, and allied species are found almost everywhere in the tropics. The larvae occur principally in tubs, barrels, cisterns and other vessels containing water, in stagnant ditches, garden pits, holes in rocks and trees, and so on. They possess a long breathing tube close to the tail fins; and float at the surface of the water with the end of this tube attached to the "surface film," and the head hanging downwards. When disturbed, they wriggle at once to the bottom. The adult insects generally present a uniform grey appearance, with pale yellowish bars across the back of the abdomen, and plain unspotted wings. They bite almost entirely in the evening and night, and principally indoors (in the tropics). The parasite which causes elephantiasis, namely the *Filaria bancrofti*, is carried by them or allied species in a manner very similar to that in which the Anophelines carry the parasites of malaria.

*Stegomyia calopus* and allied species are very common in the tropics, but much less so in temperate climates. The larvae breed in much the same places as those of *Culex*, but more frequently in vessels. Any old biscuit tin or oil tin, flower-pot, broken bottle and crockery, tub or barrel, choked drain, roof

gutter, etc., in which rain or other water has collected, is almost sure to contain them, and they frequently occur in holes in trees and in certain plants. They possess a short stumpy breathing tube, and float head downwards, like the larvae of *Culex*. The adult insects are more or less striped or speckled black and white, and have plain unspotted wings. They bite chiefly in the daytime, and often abound in woods and in the shade of trees. In America *Stegomyia calopus* carries yellow fever.

The Anophelines consist of about one hundred and twenty known species, some of which carry malaria and are always found in malarious places. The larvae occur chiefly in water on the ground, particularly in water which stands or flows amongst grass or water weeds. Thus they abound in the weedy margins of rivers, streams, lakes and ponds; in small sluggish streams and streamlets; in water courses, drains and gutters choked with weeds; in pools of rain water lying on grass; in pits from which earth has been removed, such as the "borrow pits" by the side of railway embankments; in cisterns and pits used for watering gardens; in ornamental waters; in hollows in rocks; and in water at the bottom of boats, etc. Thus while the larvae of *Culex* and *Stegomyia* occur in the small collections of water which abound in and around houses, on the other hand the Anophelines are principally *marsh mosquitos*—owing to which malaria is generally more or less connected with marshy conditions, and is called Marsh Fever, or Paludism. The larvae feed chiefly on the surface of the water—on which they float like sticks, and not with the head hanging downwards. When disturbed they swim away backwards on the surface, and sink to the bottom only when much alarmed. They have no breathing tube, like those of *Culex* and *Stegomyia*. The adults are speckled brown and white, or black and white; and generally the wings are not plain, but possess three or four black marks along or near the front border. When the insect is seated at rest on a wall, the tail projects outward at an angle from the

wall; whereas the *Culex* and *Stegomyia* sit with the tail hanging downwards, or even nearly touching the wall. All these facts enable any one to distinguish at sight both the larvae and the adults of Anophelines from those of *Culex* and *Stegomyia*. Anophelines bite chiefly at night or in the dusk — owing to which the malarial infection is generally acquired at night. They enter houses, but also bite in the open in spots sheltered from wind.

**4. Personal Prevention.** — If they can avoid it, people should not go to live in known malarious places, nor in the vicinity of marshes, nor close to an infected native population.

Even in such, however, the chances of infection can be much reduced by the careful use of mosquito nets. The net should not have the smallest hole. It should be hung *inside* the poles, when these are provided, and not outside them. It should be tucked under the mattress all round, and should never be allowed to hang down anywhere to the floor; and it should be stretched tight, in order to allow every breeze to enter, and should not be hung in loose folds, which check ventilation.

Those who can afford it should protect the windows of the house with wire gauze, and provide the doors with automatic closing arrangements. It is especially advisable to protect a room, or a part of the veranda, for sitting in during the day or evening.

Punkas and electric fans, not only drive away mosquitos, but also keep the body cool, comfortable and vigorous, even in great tropical heat.

Where there is great danger of malaria, five grains (1/3 gramme) of quinine should be taken regularly every day just before breakfast; but it is advisable to take a double dose at least once a week—say, on every Sunday.

In such localities, the hands and feet may also be protected by gloves and boots; but these cannot always be endured owing to the heat; and it is sometimes preferable to carry and use

constantly a palm-leaf fan, with which mosquitos can be driven off and the body kept cool.

A small butterfly-net of white (not green) muslin may be kept in the house for the purpose of catching troublesome mosquitos during the day; and the servants may be taught to use it. It may sometimes be easier to kill all the mosquitos in a room in this manner than by fumigation.

Mosquito traps consist of boxes lined with black cloth. Attracted by this colour mosquitos enter the box for refuge during the day. The lid or shutter is then suddenly closed and the insects within are killed by a little ammonia or chloroform poured into the box through a protected opening. Or, the lid can be made to slide down to the bottom of the box in such a manner as to crush the inmates.

To fumigate a room thoroughly for mosquitos all the chinks in the doors and windows should be closed by pasting paper over them. Then burn the culicide as follows:[1]—

1. *Sulphur.*—Allow 2 lbs. of sulphur to 1,000 cubic feet. Use two pots, place them in a pan containing 1 inch of water to prevent damage, and set fire to the sulphur by means of spirit.

   *Duration.*—Three hours.

2. *Pyrethrum.*—Allow 3 lbs. to 1,000 cubic feet, and divide amongst two or three pots, using the same precautions as with sulphur.

   *Duration.*—Three hours.

3. *Camphor and Carbolic Acid.*—Equal parts camphor and crystallised carbolic acid are fused together into a liquid by gentle heat. Vaporise 4 ozs. of mixture to each 1,000 cubic feet; this can be done by placing the liquid in a wide shallow pan over a spirit or petroleum lamp; white fumes are given off. To avoid the mixture burning, the fumes should not come in close contact with the flame of the lamp.

   *Duration.*—Two hours.

[1] As used in the United States (Sir Rubert Boyce).

Remember that sulphur tarnishes metal work and injures pianos, sewing machines, chronometers, telephones, etc.

The camphor-carbolic mixture is one of the most agreeable and effective of the various agents.

Many mosquitos may be destroyed, without troubling to cover the chinks with paper, simply by picking up and killing the stupefied insects near the windows after the fumigation.

The householder should always take care that no stagnant water is allowed to remain anywhere in his premises in cisterns, drains, gutters, tubs, jugs, flower-pots, gourds, broken bottles and crockery, old tins and other rubbish, or in holes in trees, or in certain plants such as wild pineapple — in all of which mosquitos are apt to breed. If the water cannot be emptied out, the larvae of the mosquitos in it may be destroyed by pouring a little kerosine oil, or in the case of drinking water, a little eucalyptus oil, upon the surface. This should be done once a week; and the householder should make it a habit to inspect his premises for this purpose every Sunday. Cisterns and tubs containing drinking water should be kept screened in such a manner as to prevent mosquitos laying their eggs on the surface of the water. If he follows this advice the householder will generally obtain a great reduction in the number of the insects in his house. If, however, the plague continues, he should appeal to the local sanitary authorities.

It is extremely dangerous to sleep in a house which is occupied, or has recently been occupied, by infected persons, especially native children; or in or close to an infected native village.

**5. Public Prevention.**—As a broad general rule, malaria causes a quarter or more of the total sickness in the tropics.

Malaria can always be greatly reduced, or may even be extirpated, in any locality.

Large marshes in populous places must be drained deepened or filled up.

A proper permanent organisation must be established for dealing with the smaller breeding-places of Anophelines, and for distributing quinine—especially to infected children. Other measures may be adopted where called for.

The cost is likely to be more than recouped by saving in life, labour, invaliding, medical attendance and hospital accommodation.

The campaign will remove other mosquito-borne diseases as well as malaria; and will tend to improve general sanitation in the locality where it is undertaken.

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FOR FURTHER IMFORMATION OR ASSISTANCE THE READER SHOULD APPLY TO THE LOCAL SANITARY OR MEDICAL AUTHORITIES.

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